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St. Louis Park / Edina Groundwater Volatile Organic Compounds Contamination Study

Task 1004 - Continuation of Water Level Monitoring in the Three OPCJ Wells

STS Project 200804044

December 31, 2008

Prepared by:
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December 31, 2008

Mr. Nile Fellows
Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155

Re: St. Louis Park / Edina Groundwater VOC Contamination Study – Continuation of Water Level Monitoring in the Three OPCJ Wells; STS Project 200804044, Task 1004

Dear Mr. Fellows:

We are pleased to present this report "St. Louis Park / Edina Groundwater Volatile Organic Compound Contamination Study, Task 1004: Continuation of Water Level Monitoring in the Three OPCJ Wells: Edina Well No. 7, Edina OPCJ Test Well and Meadowbrook Golf Course Well". The work was conducted following the scope of work outlined in STS Proposal 200802882, Task 1004 (September 8, 2008). The proposal was approved as stated in the Contract Work Order SFST0904 issued by MPCA on September 11, 2008.

This report presents the results of continuous water level monitoring of the three wells conducted since July 2007. If you have any questions, please contact Peter Rzepecki at 763-852-4245 or Robert DeGroot at 763-852-4217.

Sincerely,

AECOM

Peter Rzepecki, PhD, PHg, PG
Senior Hydrogeologist

Robert DeGroot, PE, PG
Principal Engineer

PR/dn
Encs.

Table of Contents

1.0 Introduction

Vinyl chloride (VC) contamination detected in the City of Edina Municipal Well Number 7 (ED-7) triggered a multi-phase investigation conducted since 2004. That investigation documented the presence of a large volatile organic compound (VOC) plume in the Prairie du Chien – Jordan Aquifer (OPCJ) and in the shallower aquifers, centered on an area within the boundaries of the City of St. Louis Park. Since the City of Edina produces the OPCJ groundwater for the municipal water supply system, there is a concern that more of the St. Louis Park VOC plume may be drawn into the Edina area and its municipal wells. Remedial actions depend on good quality monitoring data and assessment of groundwater dynamics, flow directions and contaminant concentration trends.

One of the most important monitoring activities conducted during the 2008 phase of the investigation was collection of water level data from the three wells:

- Edina Well No. 7 (ED-7, MN Unique Well No. 00206474)
- Edina OPCJ Test Well (Edina Test Well, MN Unique Well No. 00748656)
- Meadowbrook Golf Course Well (also known as W-119, further designated as Meadowbrook Well, MN Unique Well No. 00216009)

The collected data revealed trends and dynamics of the groundwater system that are of particular importance to this investigation (see Section 2 of this report).

2.0 Water Level Data

On March 8, 2005, Minnesota Department of Health (MDH) installed a transducer and data logger in ED-7 and conducted water level monitoring through June 7, 2005. However, water level in the well dropped below the transducer on June 7, 2005 and monitoring was terminated. MDH reinstalled the transducer in ED-7 on March 23, 2007 and continued collecting water level measurements once every 30 minutes till this day (the day of issuing this report).

STS has been operating a transducer and data logger in the Meadowbrook Well since May 19, 2005.

On June 6, 2007, STS staff installed a transducer and data logger in the Edina Test Well and initiated measurements of water levels in that well once every 30 minutes. The Edina Test Well became the third OPCJ well in the area in which continuous water level monitoring is taking place (the other two are ED-7 and Meadowbrook Well).

The entirety of the water level data collected beginning from 2005 is presented on Figure 1.

Monitoring water levels at the three wells allowed calculation of a horizontal hydraulic gradient magnitude (ft/ft) and direction of groundwater flow in the important area of the boundary between the Cities of St. Louis Park and Edina. STS developed a proprietary Excel spreadsheet program to automate these gradient calculations and the results are summarized on a sequence of figures numbered 2 through 19.

Hydraulic Gradient during the Summer of 2007

Figure 2 demonstrates that during the summer of 2007 groundwater was flowing from the direction of St. Louis Park toward Edina 27.06% of the time (1.75% + 7.48% + 17.83%) (flow angle range from 225° to 360°; explanation: groundwater flow direction 0° or 360 ° equals flow toward east, flow direction 180° equals flow toward west, etc.).

Figure 3 demonstrates that groundwater flow during summer of 2007 was frequently shifting from one direction to another.

Figure 4 demonstrates that most of the time groundwater gradient during the summer of 2007 was in a range of 0.0001 ft/ft to 0.0005 ft/ft (explanation: water level along the direction of groundwater flow was dropping from 1 foot to 5 feet per 10,000 feet of horizontal distance along the direction of groundwater flow).

Hydraulic Gradient during the Fall of 2007

Figure 5 demonstrates that during fall of 2007 groundwater was flowing from the direction of St. Louis Park toward Edina (flow angle range from 225° to 360°) 48.41% of the time (1.87% + 8.20% + 38.34%). That 48.41% does not

include a two week period of time when the data is missing. Based on inspection of Figure 6, it is interpreted that during that time of missing data, groundwater was flowing mainly toward the NE part of Edina, in the direction bracketed by 315° to 360°.

Figure 6 demonstrates that groundwater flow during fall of 2007 was flowing most of the time in the direction ranging from 315° to 360° (toward NE part of Edina). In the late part of fall 2007, groundwater was flowing in the direction ranging from 45° to 90° (toward NNE and away from Edina).

Figure 7 demonstrates that in the early part of fall 2007 groundwater gradient was in a range of 0.0002 ft/ft to 0.0004 ft/ft. During mid- and late part of fall 2007 groundwater gradient was higher - in a range of 0.0005 ft/ft to 0.0008 ft/ft.

Hydraulic Gradient during the Winter of 2008

Figure 8 demonstrates that during winter of 2008 groundwater was flowing from the direction of St. Louis Park toward Edina (flow angle range from 225° to 360°) only 0.98% of the time (0.00% + 0.00% + 0.98%).

Figure 9 demonstrates that groundwater flow during winter of 2008 most of the time was not changing direction, which was predominantly E – ENE (the direction ranging from 0° to 45°), away from Edina.

Comparison of Figures 10 and 7 demonstrates groundwater gradient during winter of 2008 was most of the time higher than during summer and fall 2007 - in a range of 0.0004 ft/ft to 0.0012 ft/ft.

Hydraulic Gradient during the Spring of 2008

Figure 11 demonstrates that during spring of 2008 groundwater was flowing from the direction of St. Louis Park toward Edina (flow angle range from 225° to 360°) 42.78% of the time (0.00% + 0.13% + 42.65%).

Figure 12 demonstrates that groundwater flow during spring of 2008 most of the time was not changing direction, which was predominantly ESE (the direction ranging from 315° to 360°), away from Edina.

Figure 13 demonstrates that most of the time groundwater gradient during spring of 2008 was in a range of 0.0004 ft/ft to 0.0008 ft/ft.

Hydraulic Gradient during the Summer of 2008

Figure 14 demonstrates that during summer of 2008 groundwater was flowing from the direction of St. Louis Park toward Edina (flow angle range from 225° to 360°) most of the time – 68.93% of the time (0.40% + 3.24% + 65.29%).

Figure 15 demonstrates that groundwater flow during summer of 2008 was migrating predominantly in ESE direction (the direction ranging from 315° to 360°).

Figure 16 demonstrates that most of the time groundwater gradient during summer of 2008 was in a range of 0.0002 ft/ft to 0.0008 ft/ft.

Hydraulic Gradient during the Fall of 2008

Figure 17 demonstrates that during fall of 2008 groundwater was migrating from the direction of St. Louis Park toward Edina (flow angle range from 225° to 360°) 43.83% of the time (0.30% + 0.90% + 42.63%).

Figure 18 demonstrates that groundwater flow during fall of 2008 was migrating predominantly in an eastern direction, although during late fall the direction shifted more toward northeast, with periods of time when groundwater was moving to the west.

Figure 19 demonstrates that groundwater gradient during fall of 2008 was changing over a wide range of values (from close to 0.0000 ft/ft to over 0.0012 ft/ft) with general decline in gradients toward the end of fall.

3.0 Discussion and Recommendations

Figure 1 presents the entire water level data collected from the three OPCJ wells beginning from 2005. It demonstrates the presence of a highly dynamic groundwater system with the distinct seasonal cycles of water levels. Water levels during summer time drop about 40 feet below water levels measured during winter time when the water demand is the lowest. This pattern of seasonal fluctuations is consistent.

The program of continuous water level measurements at the three OPCJ wells started on June 6, 2007. This program allowed calculation of hydraulic gradients and horizontal direction of groundwater migration. The results of these calculations are presented on Figures 2 through 19. The figures illustrate that both of the calculated parameters (1. horizontal direction of groundwater migration; 2. horizontal hydraulic gradient) continuously vary in response, primarily, to the changing configuration of water production from the area's municipal wells. Figures 2, 5, 8, 11, 14 and 17 present the seasonal averages. The other figures (of the 1 through 19 set of figures) illustrate a highly dynamic nature of this groundwater system, with flow directions and gradients continuously changing.

What is of particular importance for the Edina VOC study is the fact that groundwater is migrating from St. Louis Park toward the northeast part of Edina a large portion of the time. During the monitoring period, groundwater was moving from St. Louis Park toward Edina about:

- 27% of the time during summer of 2007
- 48% of the time during fall of 2007
- 1% of the time during winter of 2008
- 43% of the time during spring of 2008
- 69% of the time during summer of 2008
- 44% of the time during fall of 2008

As this tabulation above and Figure 20 illustrate, the only season, among the six seasons monitored so far, when groundwater was consistently migrating away from Edina was winter of 2008.

The regional data indicate that under natural conditions groundwater flow direction would be toward the east. Changing groundwater directions and gradients at Edina and St. Louis Park are primarily influenced by intense production from the area's municipal wells. Among the likely principal factors responsible for seasonal variations in groundwater production are changes in water demand. Differences between the summers of 2007 and 2008 may have been caused by different precipitation patterns and demands for watering of lawns.

It is recommended that this water level monitoring program is continued as a minimum through the end of spring, 2009. Such continuation would allow collection of 3-point dataset embracing two full years and eight seasons. The

collected data would allow comparisons of groundwater flow direction patterns between not only seasons but also years.

After the full two years of water level monitoring, the collected information should be analyzed and correlated with groundwater production, precipitation and other relevant data.

4.0 General Qualifications

AECOM professional services have been performed, data collected, analyzed and findings obtained in accordance with generally accepted engineering and hydrogeologic principles and standard practices. No other warranty, either expressed or implied, is made. AECOM assumes no responsibility for data or interpretations made by others. AECOM accepts no responsibility for application or interpretation of the results by anyone other than the client.

Figure 1. Edina Well No. 7, Edina Well No. 13, Meadowbrook Golf Course Well (W119) and Edina OPCJ Test Well Hydrographs

STS Project No. 200804044

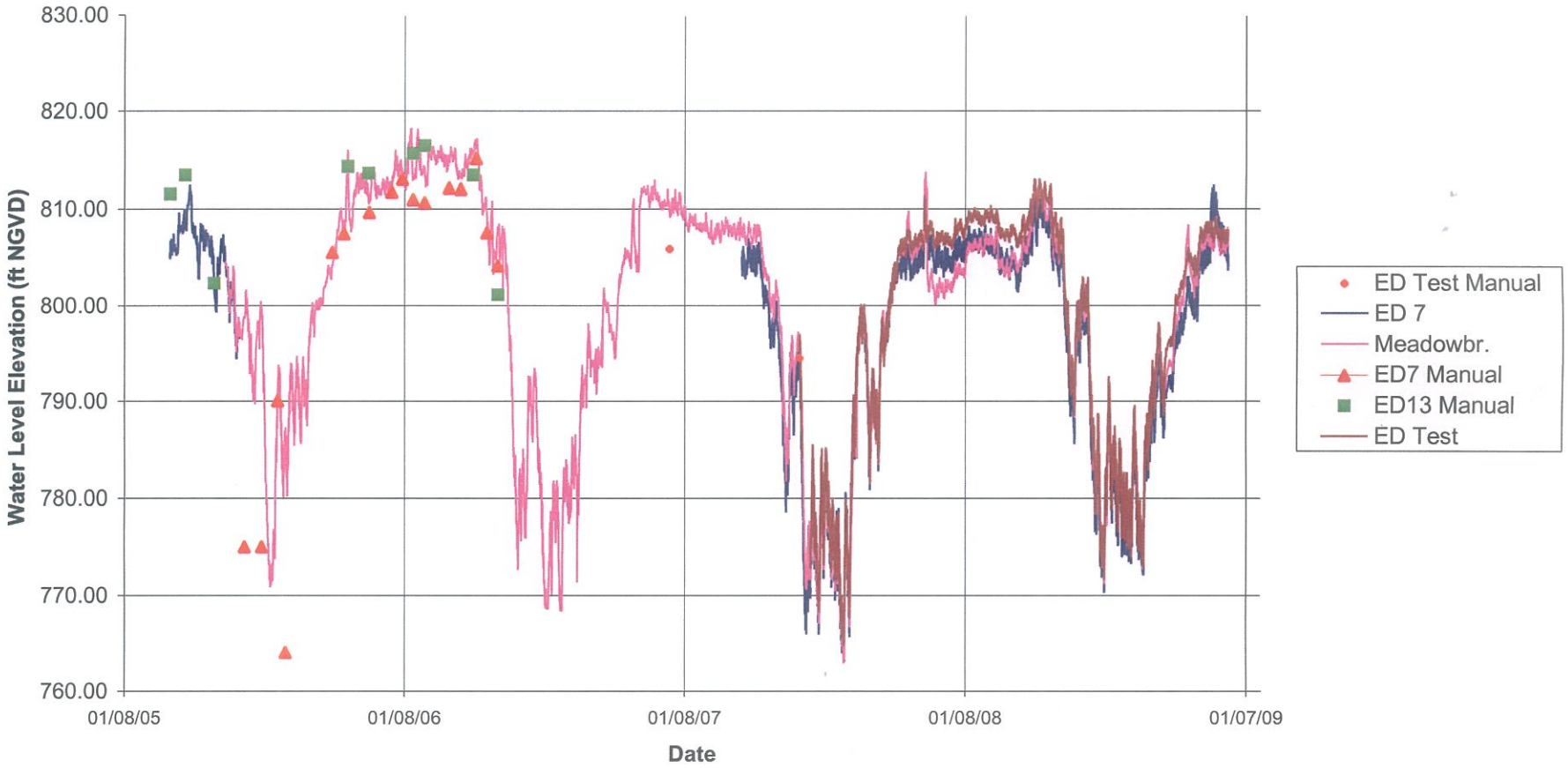
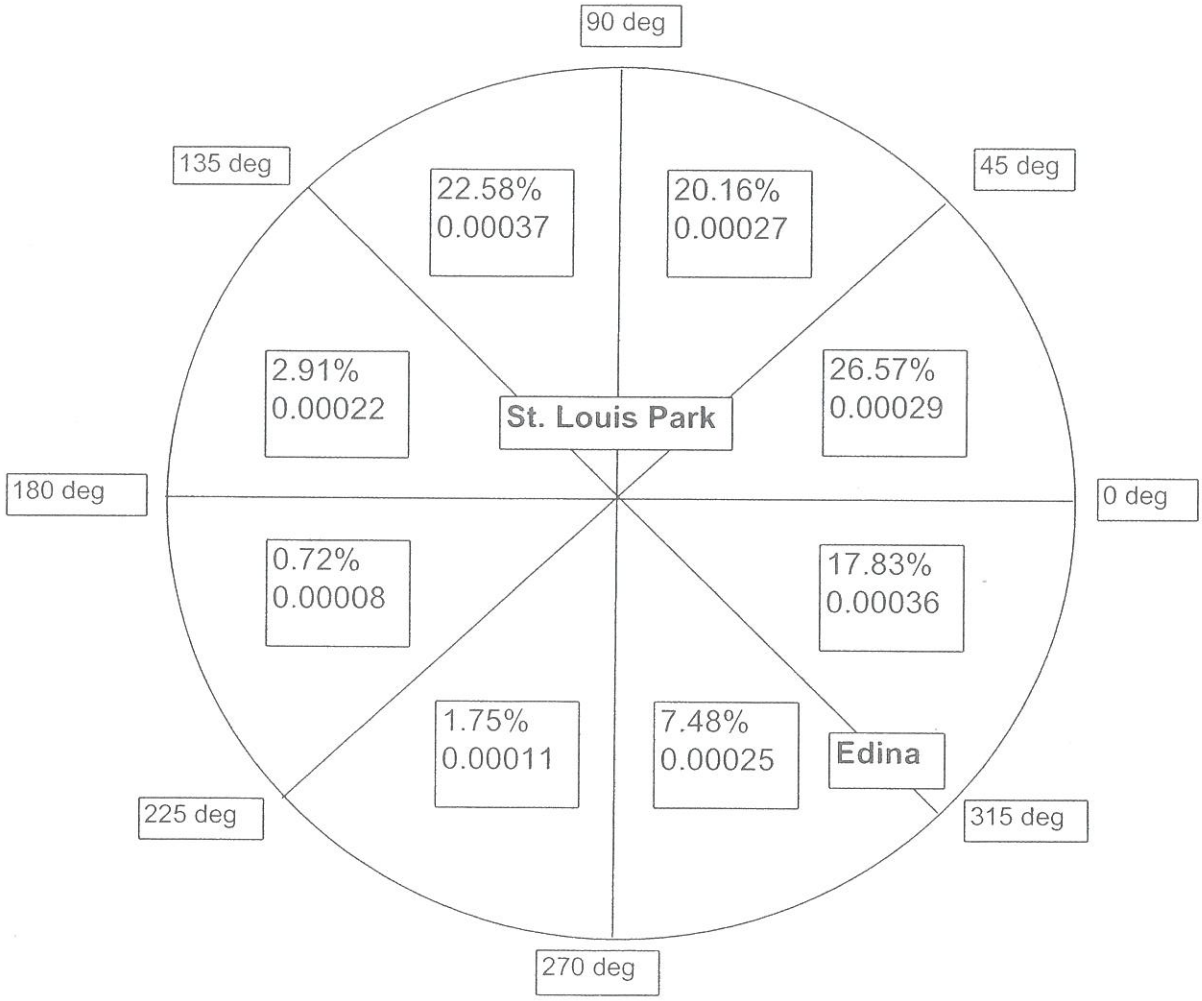


Figure 2. OPCJ Gradient Direction (0 - 360 deg) and Magnitude (ft/ft) Summer 2007 (6/21/07 - 9/21/07)

STS Project 200804044



Note: The figure shows:

17.83%	- percentage of the time during Summer 2007 groundwater flowed in a particular 45 deg direction range
0.00036	- average gradient when groundwater flowed in that particular 45 deg direction range
90 deg	- North
180 deg	- West
270 deg	- South
0 deg	- East

Figure 3. Changing OPCJ Gradient Direction - St. Louis Park / Edina - Summer 2007
STS Project No. 200804044

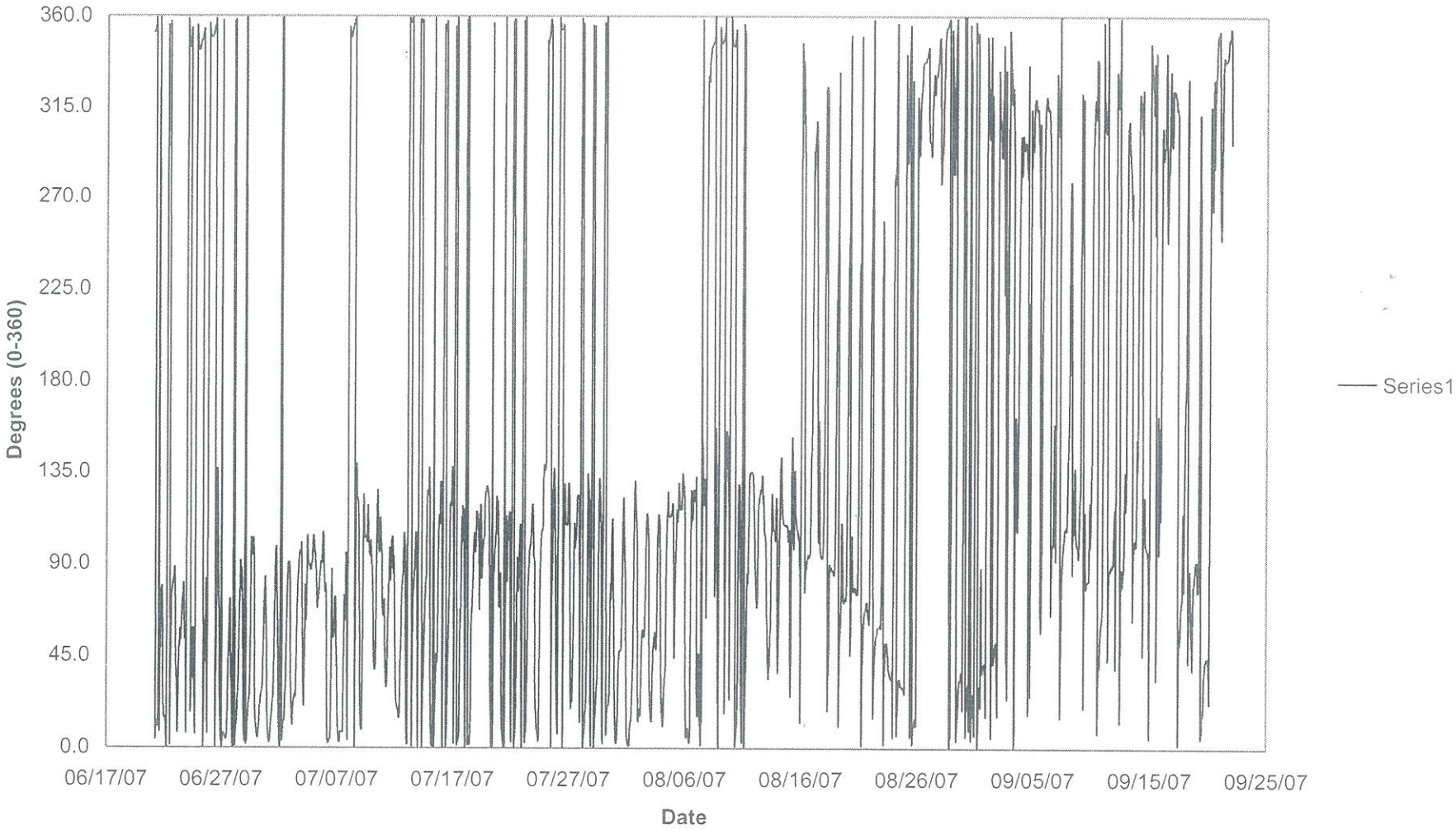


Figure 4. Change in OPCJ Gradient Magnitude with Time - St. Louis Park / Edina - Summer 2007
STS Project No. 200804044

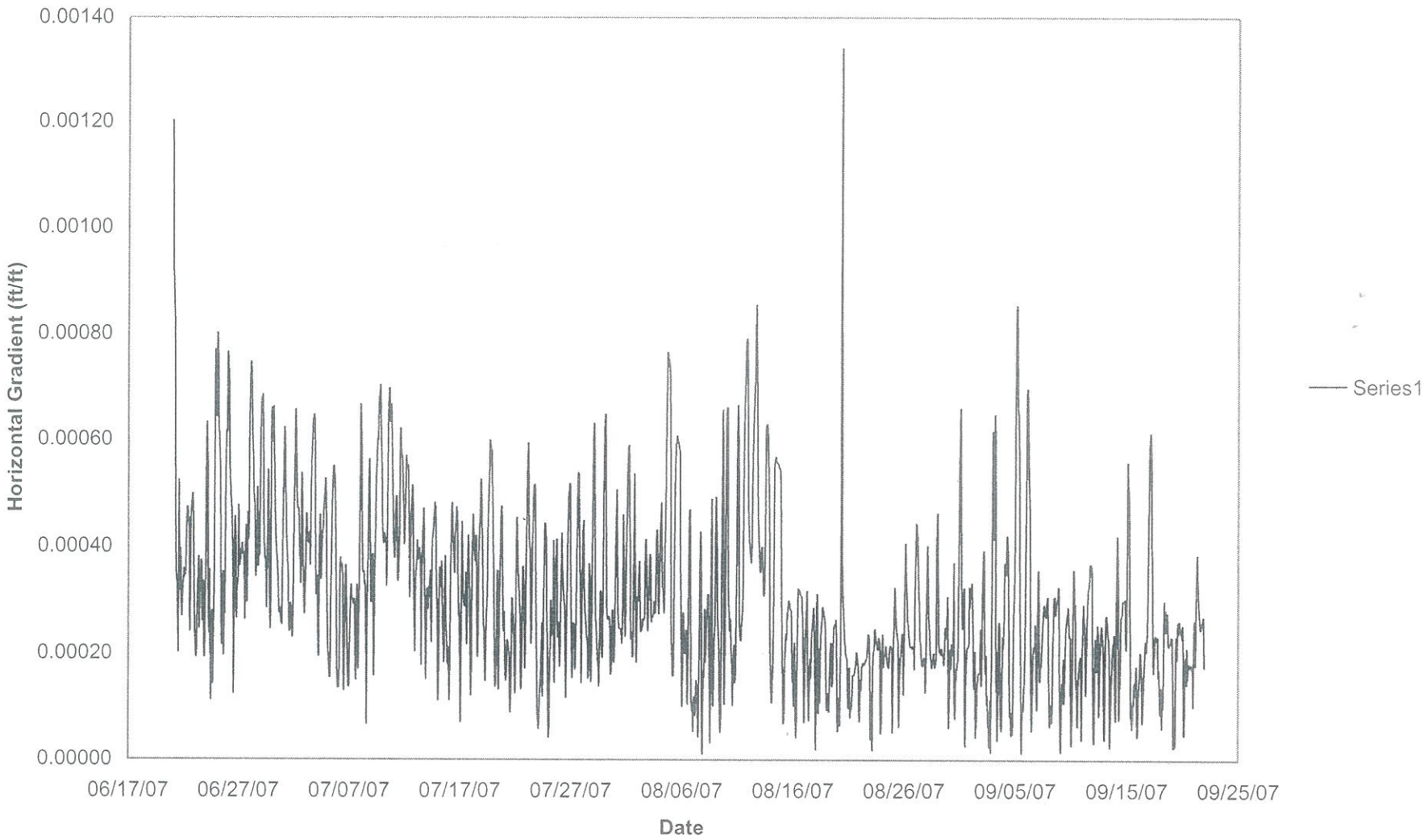
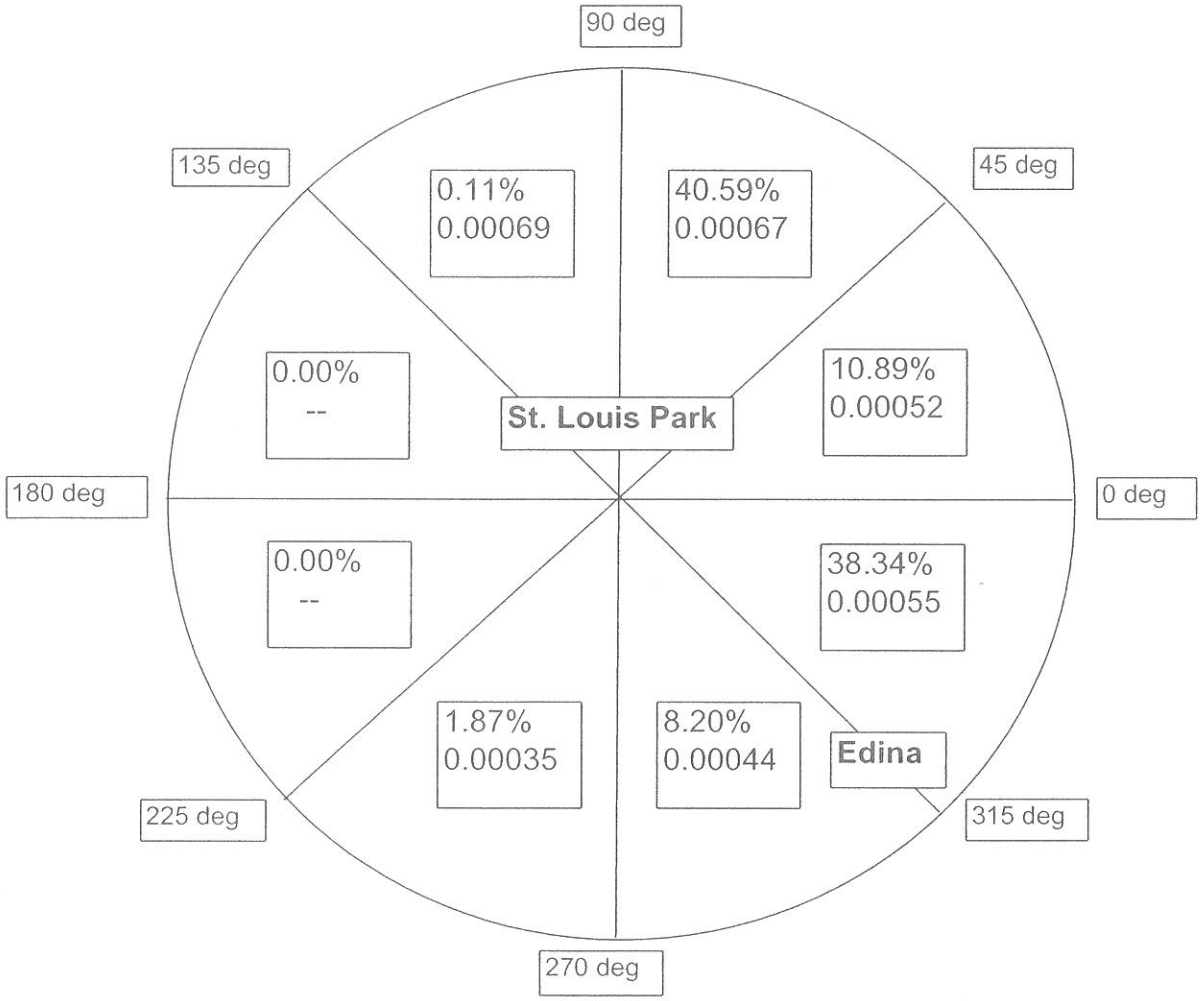


Figure 5. OPCJ Gradient Direction (0 - 360 deg) and Magnitude (ft/ft) Fall 2007 (9/22/07 - 12/21/07)

STS Project 200804044



Note: The figure shows:

38.34%	- percentage of the time during Fall 2007 groundwater flowed in a particular 45 deg direction range
0.00055	- average gradient when groundwater flowed in that particular 45 deg direction range
90 deg	- North
180 deg	- West
270 deg	- South
0 deg	- East

Figure 6. Changing OPCJ Gradient Direction - St. Louis Park / Edina - Fall 2007
STS Project No. 200804044

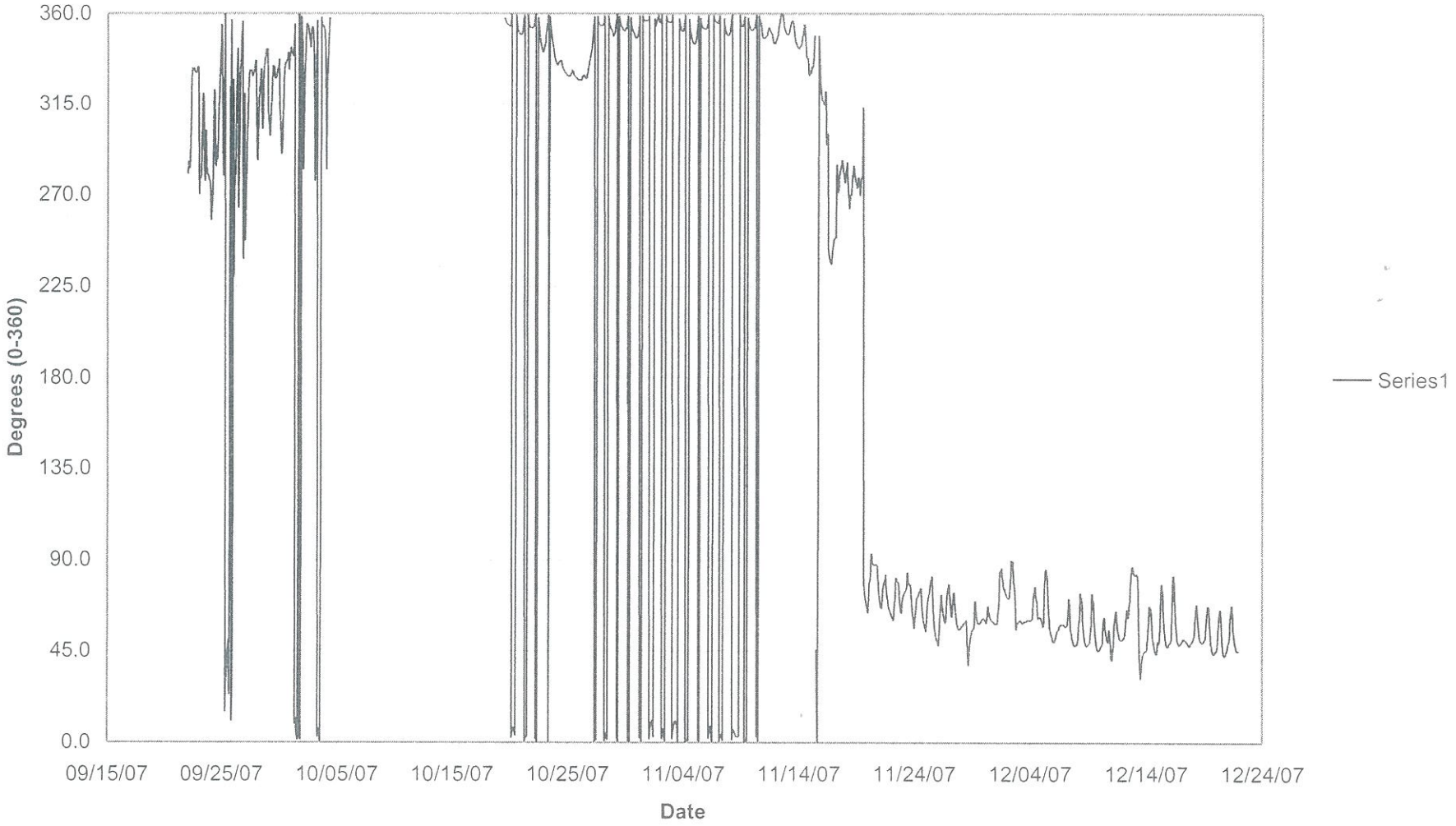


Figure 7. Change in OPCJ Gradient Magnitude with Time - St. Louis Park / Edina - Fall 2007
STS Project No. 200804044

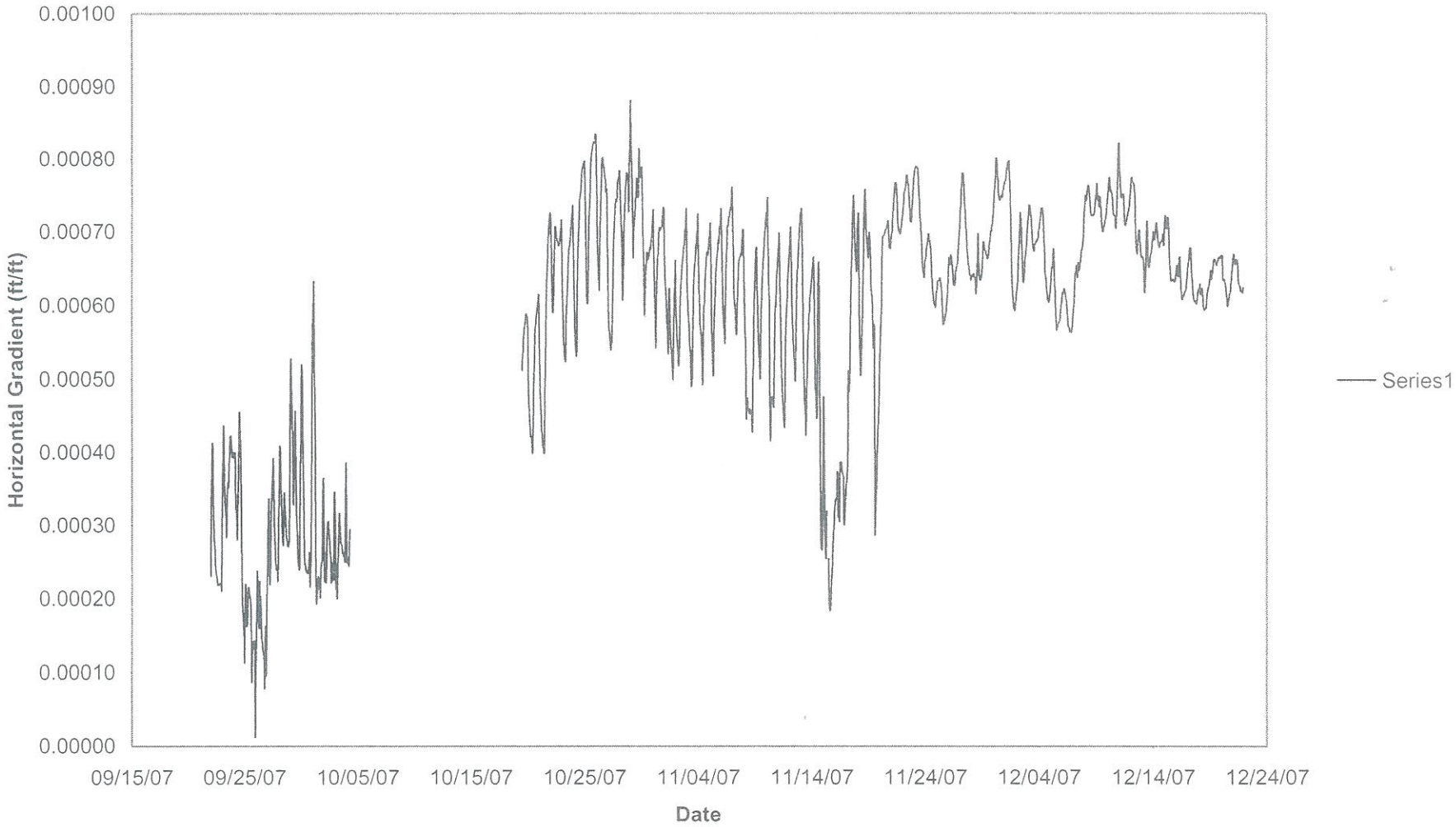
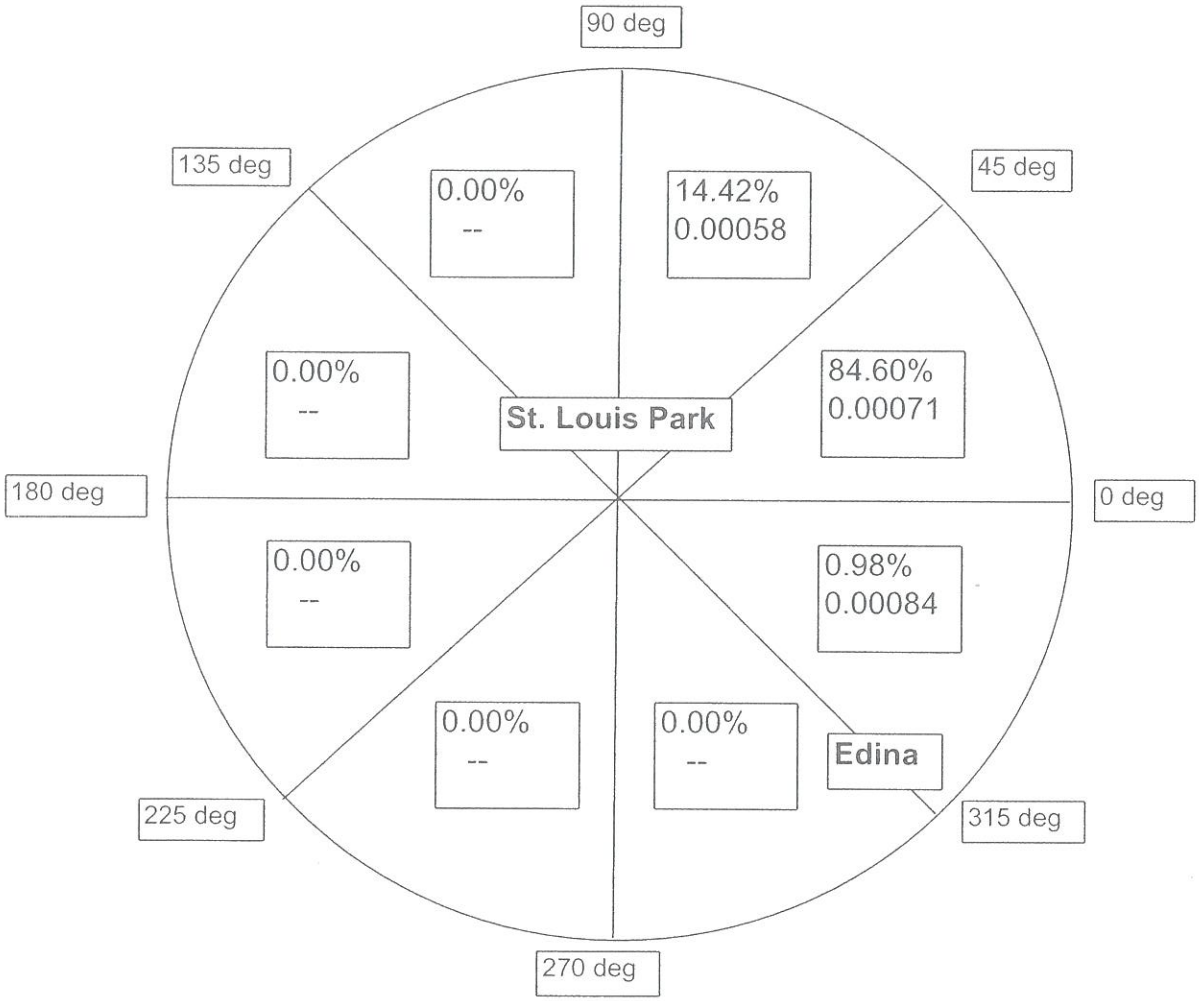


Figure 8. OPCJ Gradient Direction (0 - 360 deg) and Magnitude (ft/ft) Winter 2008 (12/22/07 - 3/19/08)

STS Project 200804044



Note: The figure shows:

0.98%	- percentage of the time during Winter 2007 groundwater flowed in a particular 45 deg direction
0.00084	- average gradient when groundwater flowed in that particular 45 deg direction range
90 deg	- North
180 deg	- West
270 deg	- South
0 deg	- East

Figure 9. Changing OPCJ Gradient Direction - St. Louis Park / Edina - Winter 2008
STS Project No. 200804044

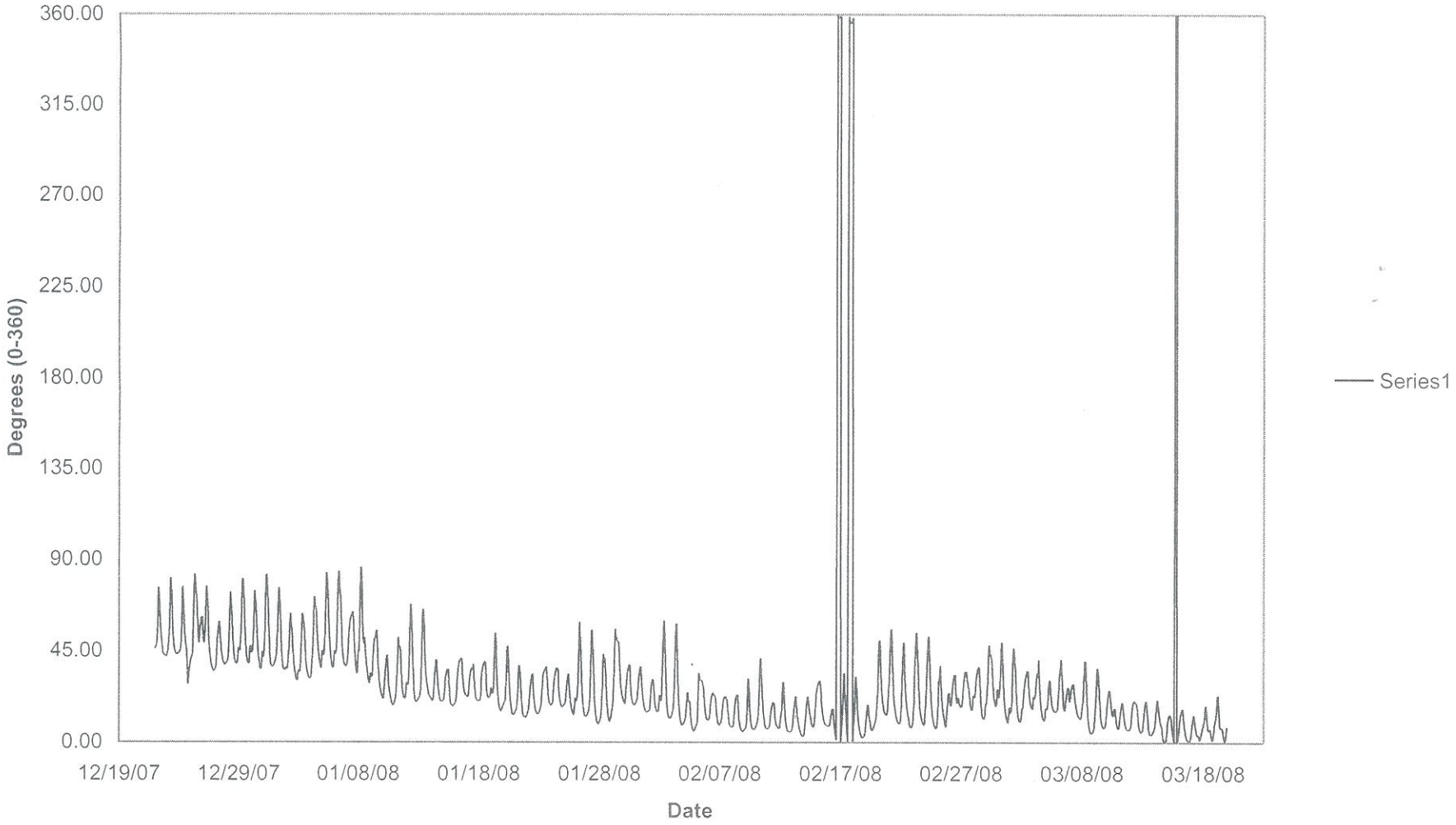


Figure 10. Change in OPCJ Gradient Magnitude with Time - St. Louis Park / Edina - Winter 2008
STS Project No. 200804044

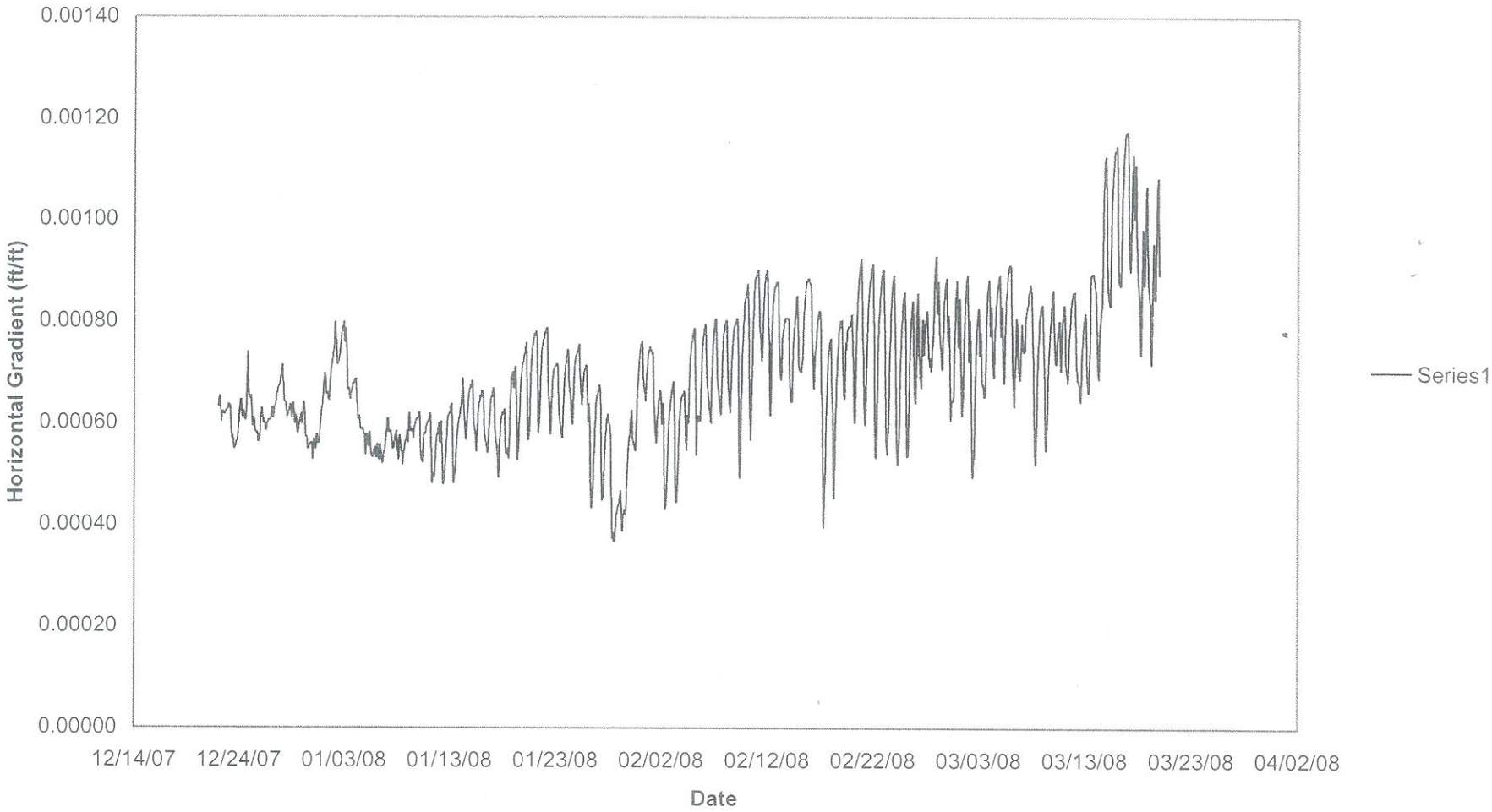
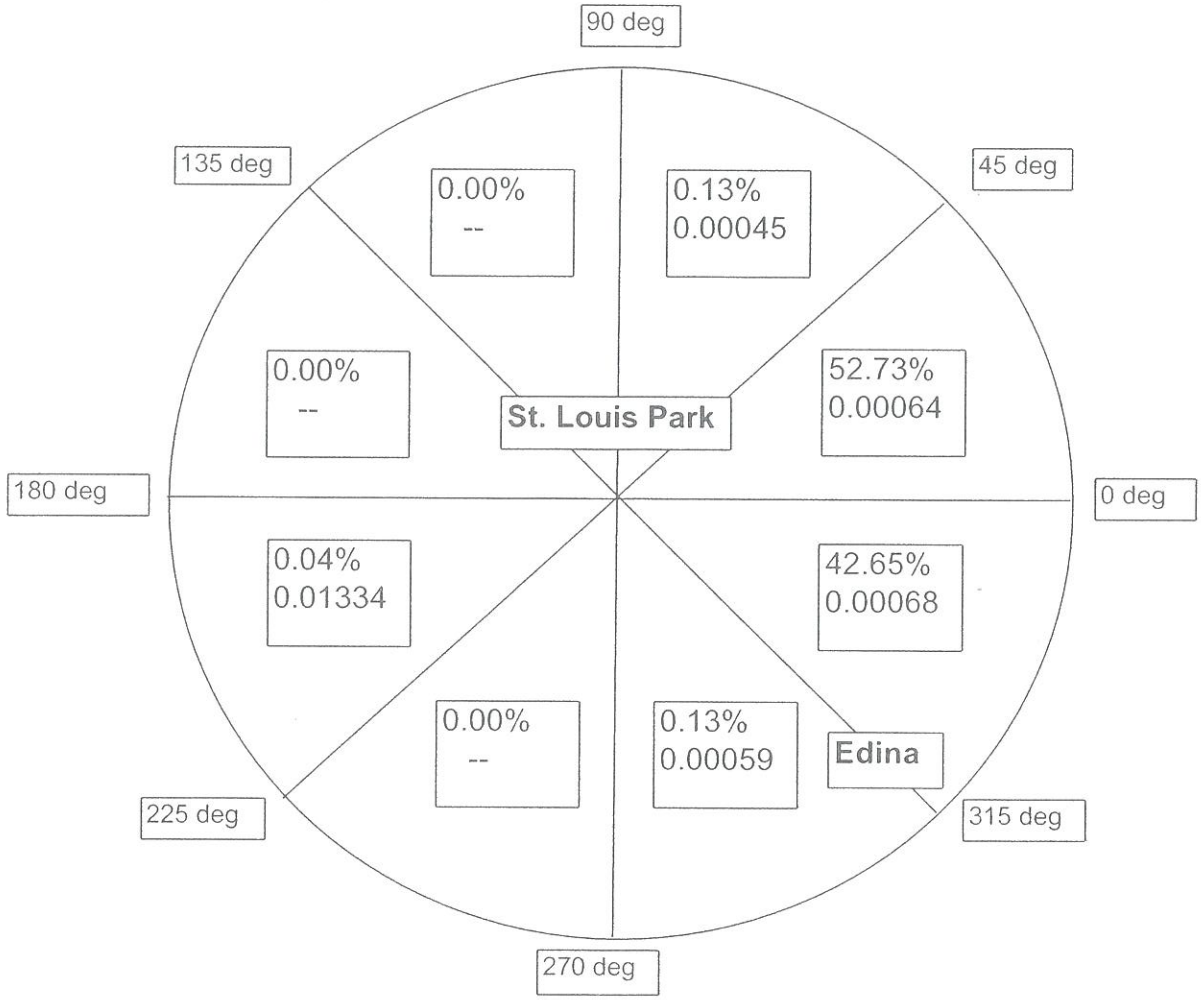


Figure 11. OPCJ Gradient Direction (0 - 360 deg) and Magnitude (ft/ft) Spring 2008 (3/20/08 - 6/20/08)

STS Project 200804044



Note: The figure shows:

42.65%	- percentage of the time during Spring 2008 groundwater flowed in a particular 45 deg direction
0.00068	- average gradient when groundwater flowed in that particular 45 deg direction range
90 deg	- North
180 deg	- West
270 deg	- South
0 deg	- East

Figure 12. Changing OPCJ Gradient Direction - St. Louis Park / Edina - Spring 2008
STS Project No. 200804044

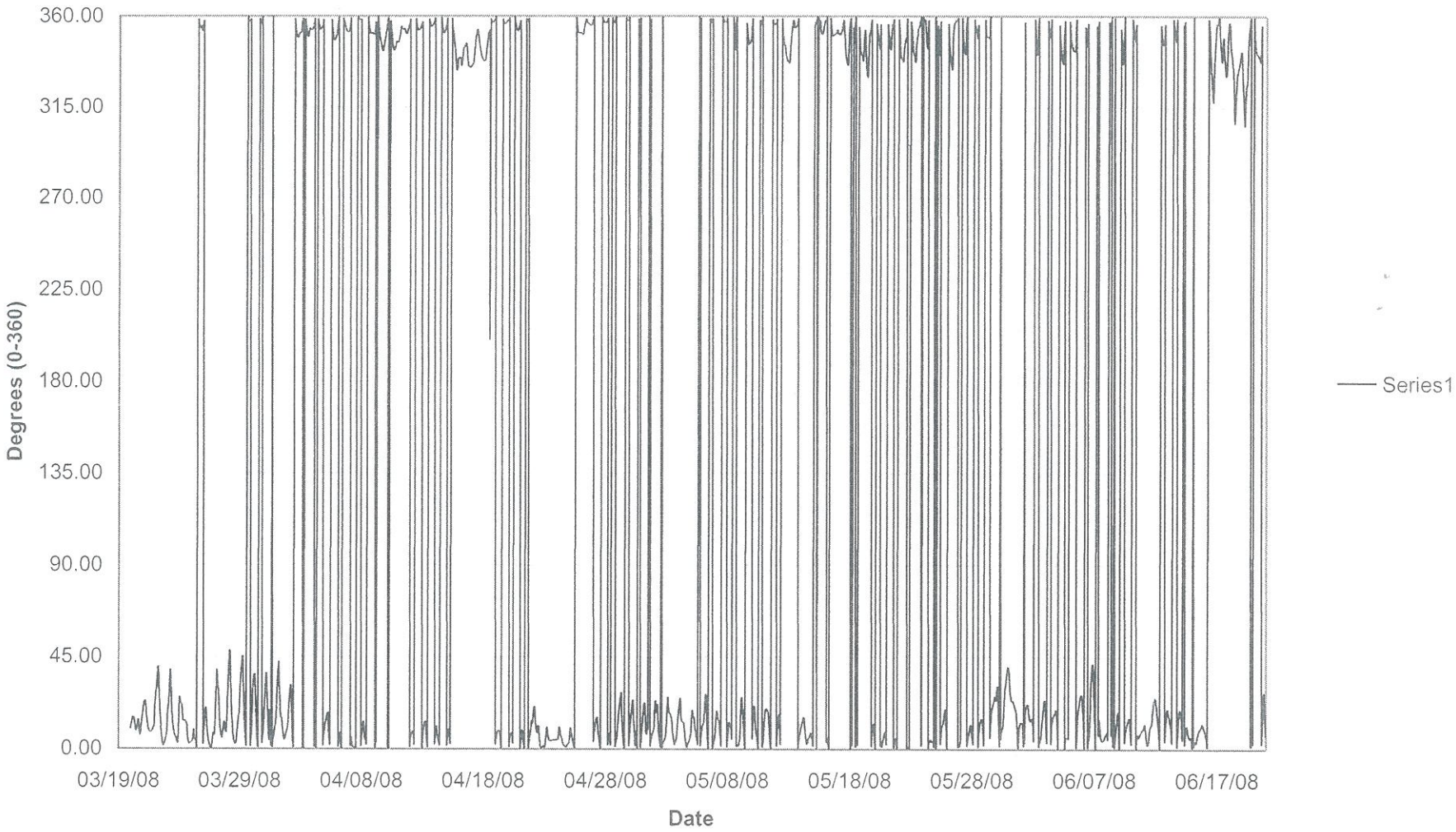


Figure 13. Change in OPCJ Gradient Magnitude with Time - St. Louis Park / Edina - Spring 2008
STS Project No. 200804044

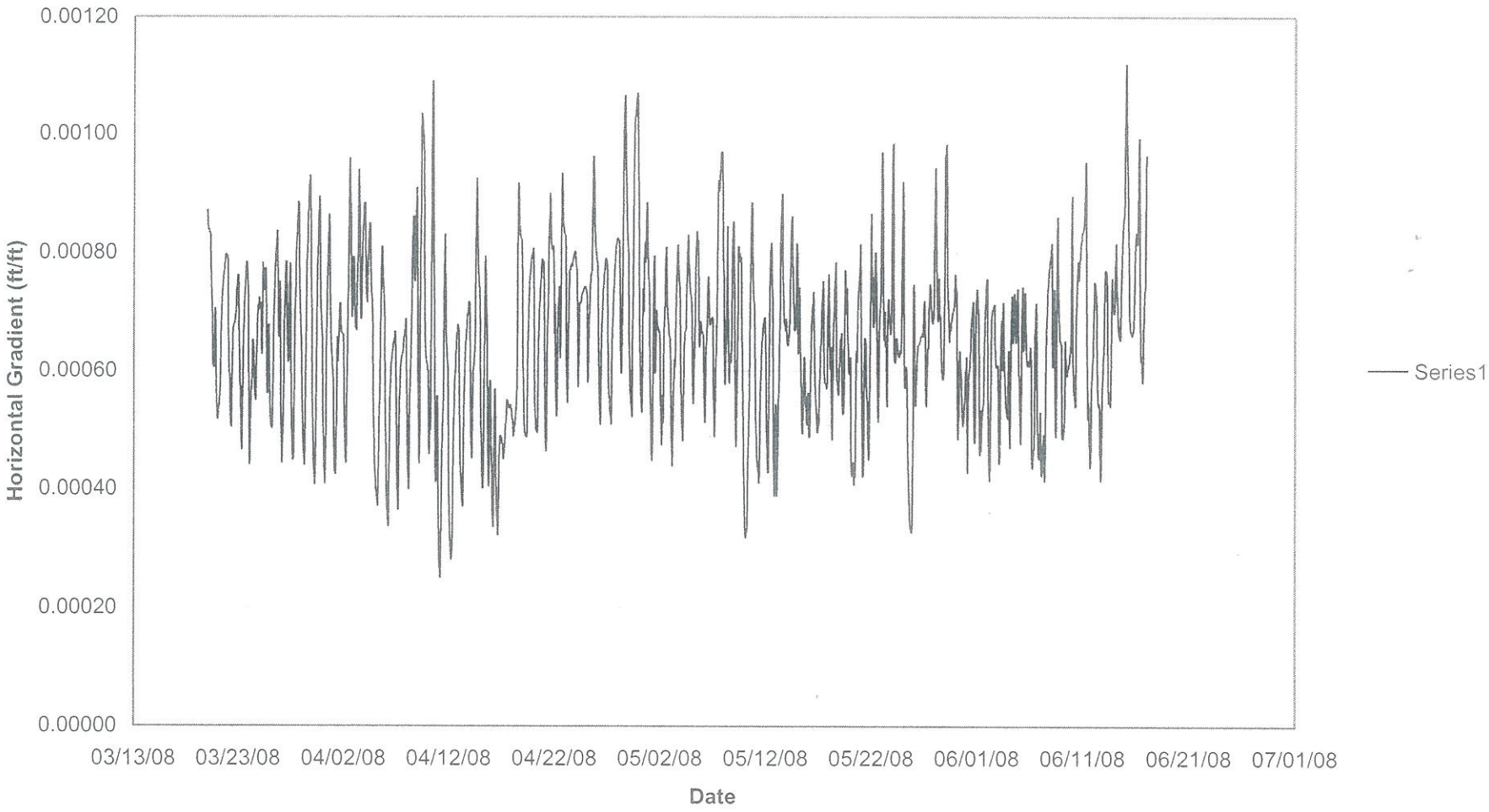
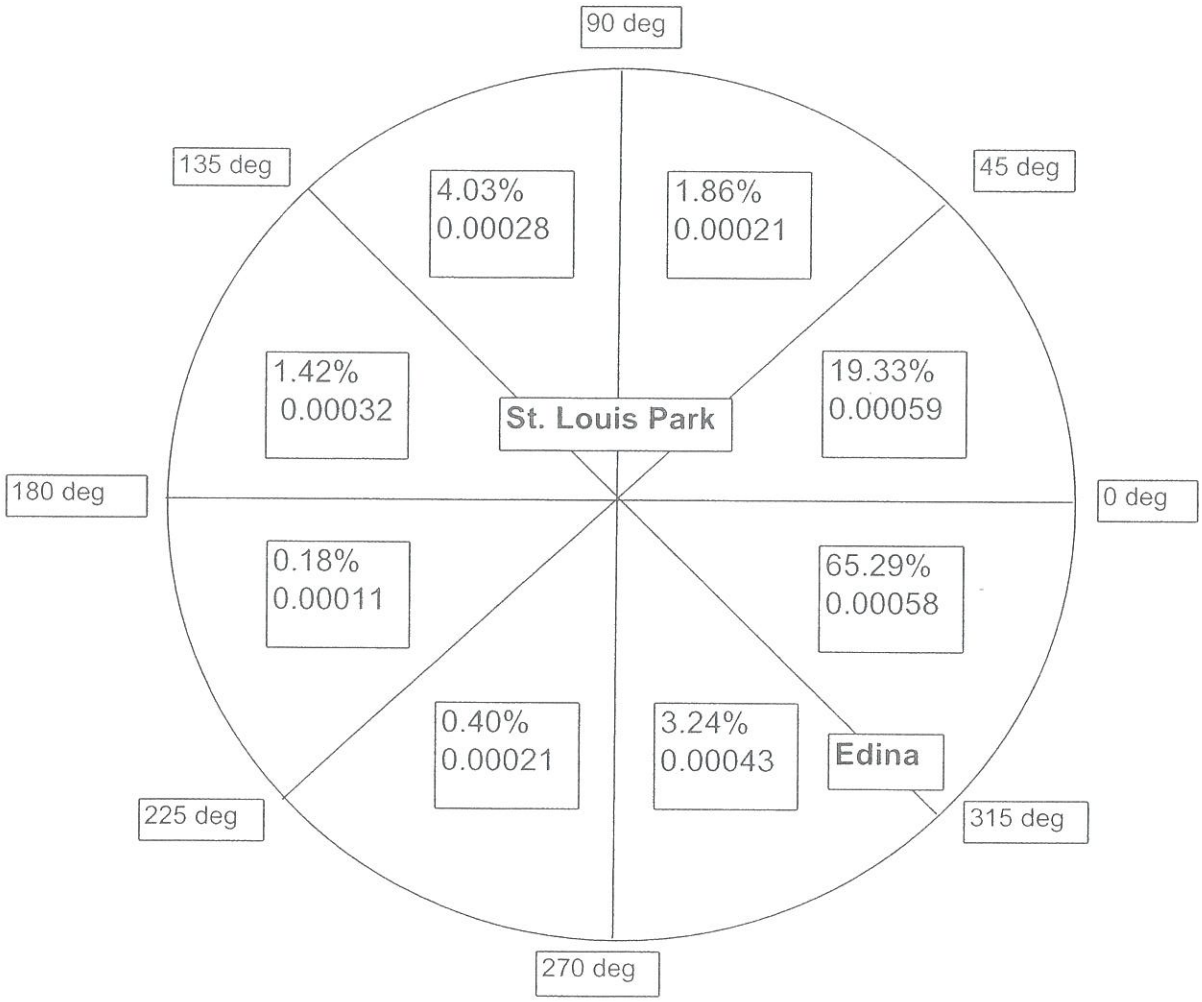


Figure 14. OPCJ Gradient Direction (0 - 360 deg) and Magnitude (ft/ft) Summer 2008 (6/21/08 - 9/22/08)

STS Project 200804044



Note: The figure shows:

65.29%	- percentage of the time during Summer 2008 groundwater flowed in a particular 45 deg direction
0.00058	- average gradient when groundwater flowed in that particular 45 deg direction range
90 deg	- North
180 deg	- West
270 deg	- South
0 deg	- East

Figure 15. Changing OPCJ Gradient Direction - St. Louis Park / Edina - Summer 2008
STS Project No. 200804044

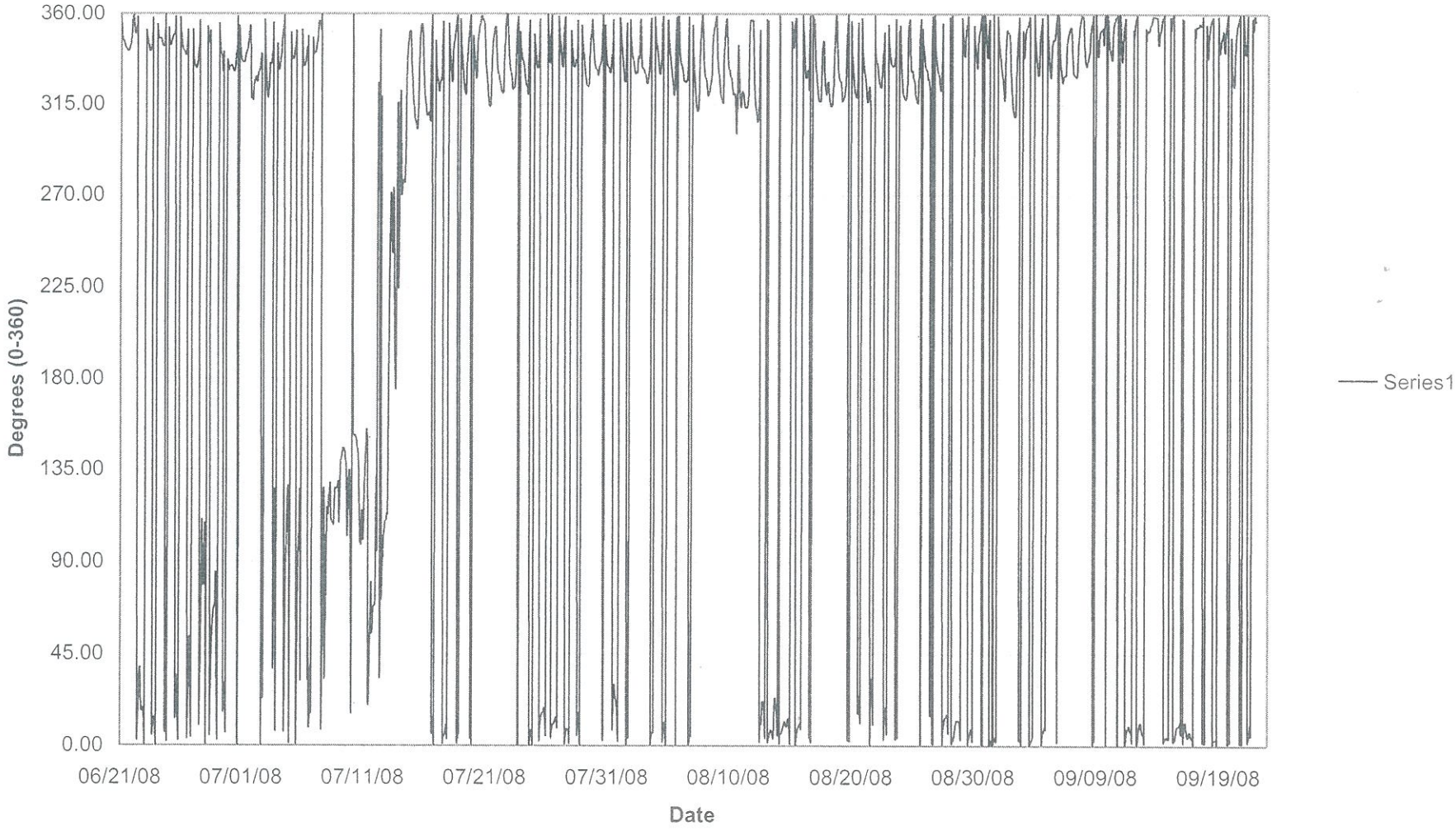


Figure 16. Change in OPCJ Gradient Magnitude with Time - St. Louis Park / Edina - Summer 2008
STS Project No. 200804044

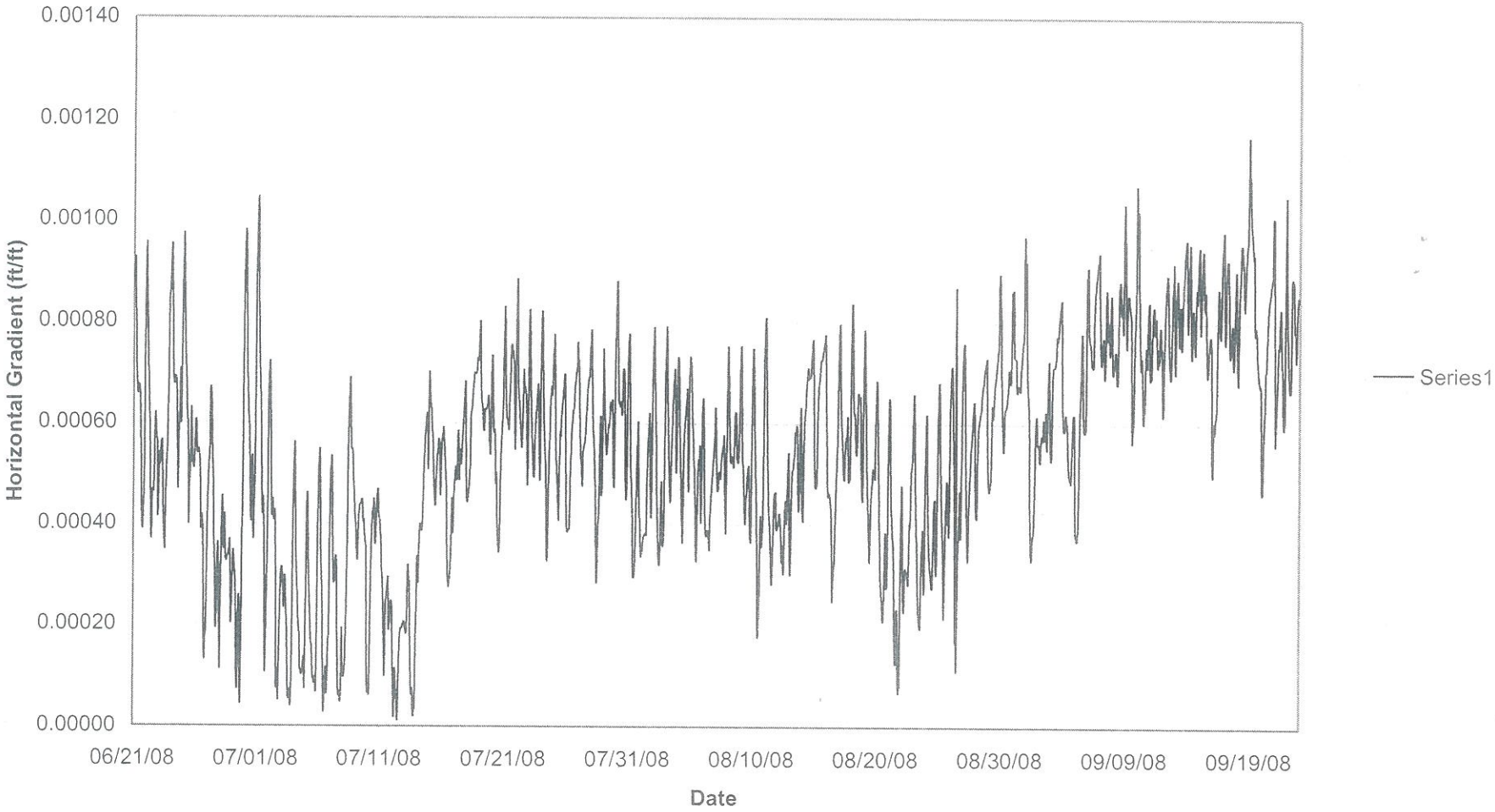
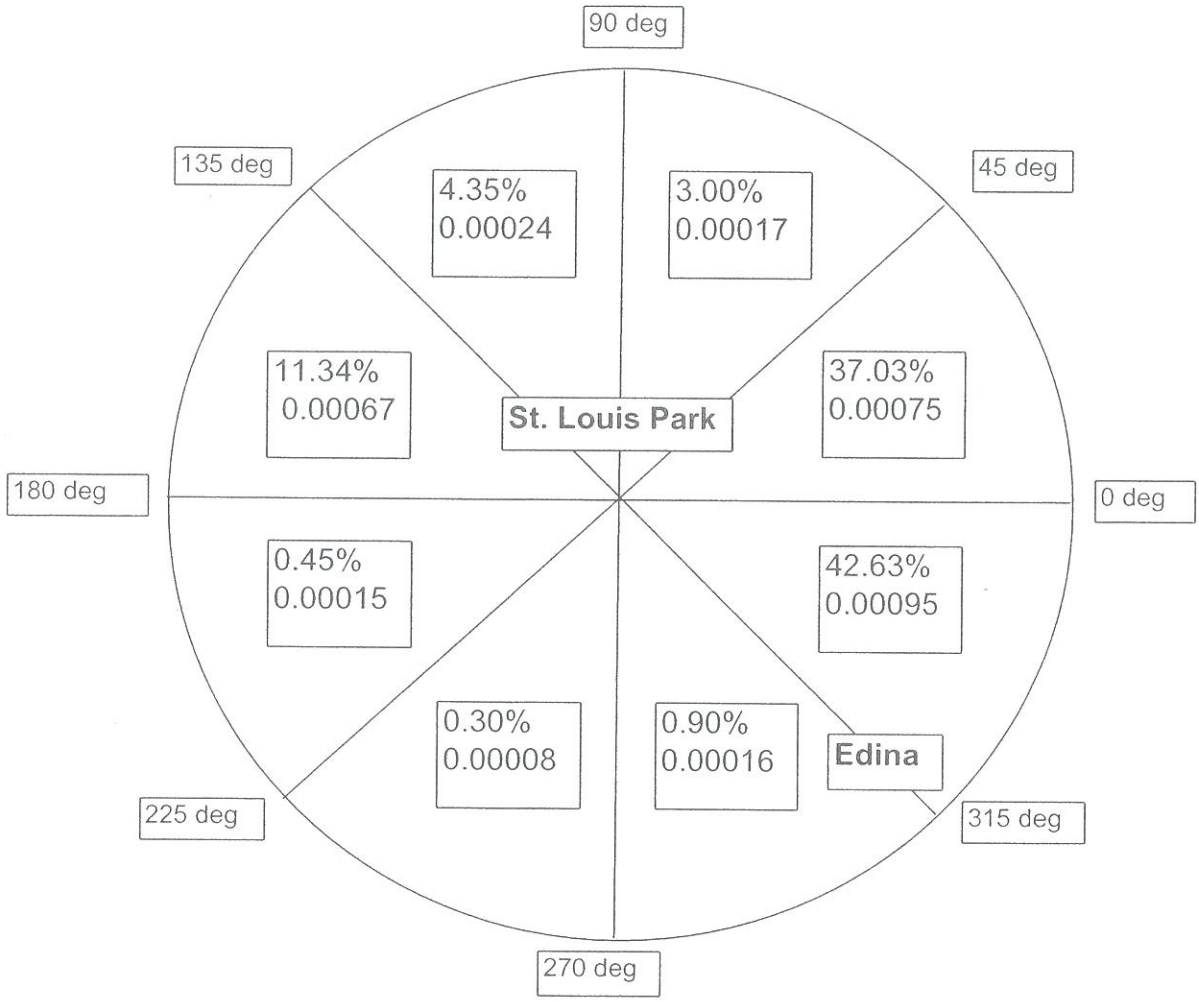


Figure 17. OPCJ Gradient Direction (0 - 360 deg) and Magnitude (ft/ft) Fall 2008 (9/23/08 - 12/15/08)

STS Project 200804044



Note: The figure shows:

42.63%	- percentage of the time during Fall 2008 groundwater flowed in a particular 45 deg direction
0.00095	- average gradient when groundwater flowed in that particular 45 deg direction range
90 deg	- North
180 deg	- West
270 deg	- South
0 deg	- East

Figure 18. Changing OPCJ Gradient Direction - St. Louis Park / Edina - Summer 2008
STS Project No. 200804044

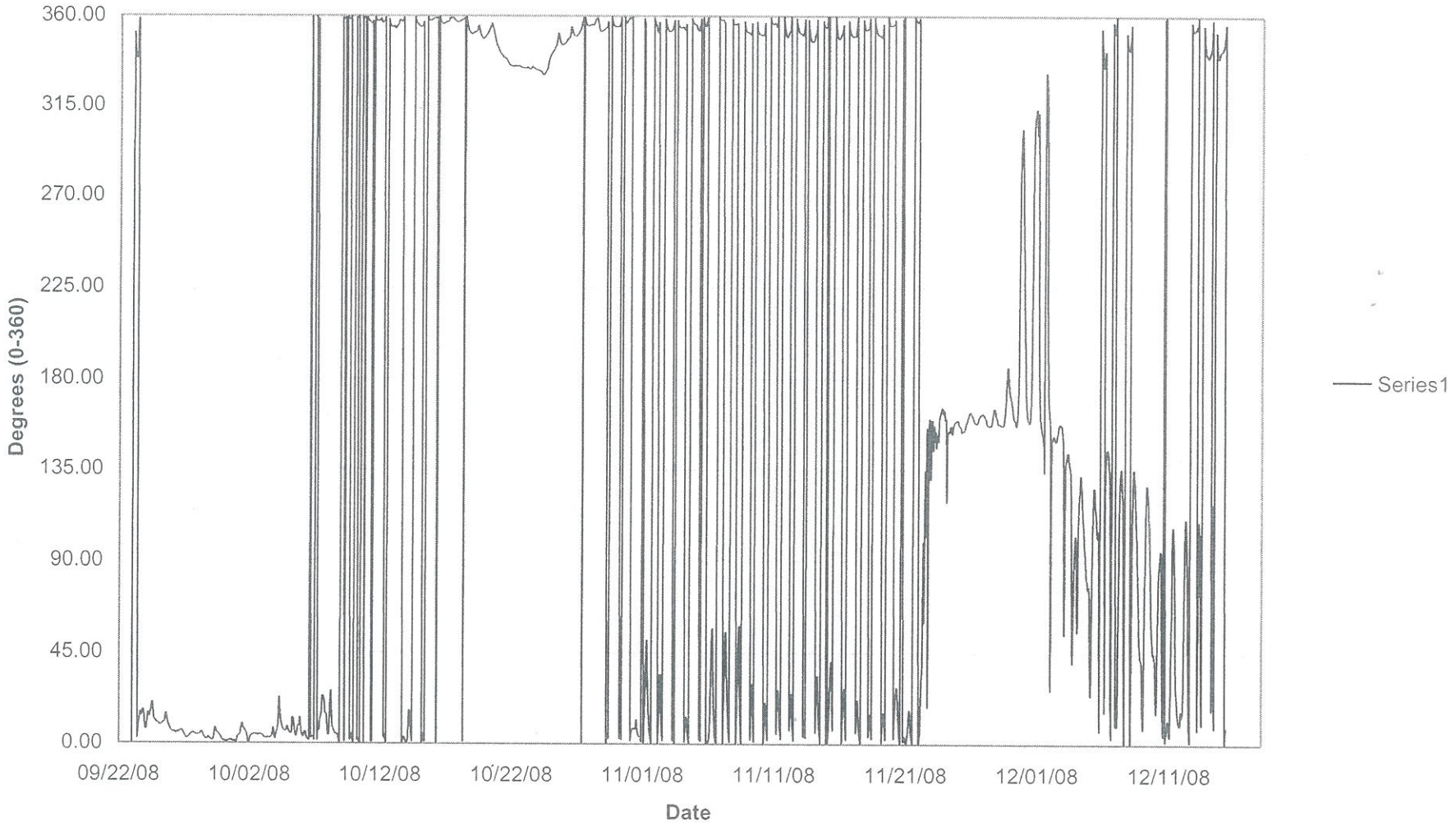


Figure 19. Change in OPCJ Gradient Magnitude with Time - St. Louis Park / Edina - Summer 2008
STS Project No. 200804044